DOCUMENT RESUME

ED 367 791 CE 065 784

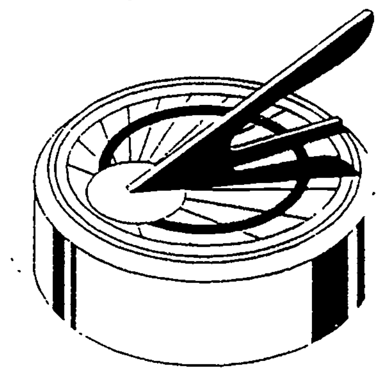
TITLE	Heat Energy. 7th and 8th Grade Agriculture Science Curriculum. Teacher Materials.
INSTITUTION	Southern Illinois Univ., Carbondale. Dept. of Agricultural Education and Mechanization.
SPONS AGENCY	Illinois State Board of Education, Springfield. Dept. of Adult, Vocational and Technical Education.
PUB DATE	93
NOTE	83p.; For the other titles in this set, see CE 065 785-789.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Agricultural Education; Agricultural Production; Classroom Techniques; Competence; Competency Based Education; Construction Materials; Course Content; Curriculum Guides; Facilities; Grade 7; Grade 8; *Heat; Integrated Curriculum; Junior High Schools; Learning Activities; Lesson Plans; Teaching Methods; Test Items; Transparencies; Units of Study
IDENTIFIERS	Agricultural Sciences

ABSTRACT

This curriculum guide the first of a series of six, contains teacher and student materials for a unit on heat energy prepared as part of a seventh- and eighth-grade agricultural science curriculum that is integrated with science instruction. The guide contains the state goals and sample learning objectives for each goal for students in grades 8-10 and a teacher presentation outline for the unit. The unit, which begins by listing the agricultural practices and science concepts to be taught, along with activities and applications, contains the following components: teaching steps, lesson outlines, teacher's presentation outlines for each day, student information guide, terms and definitions, worksheets, student activity note sheets, student activity information sheets, student activity record sheets, quizzes, practice problems, and 14 transparency masters. Teacher's activity sheets and tests have answers provided. The unit covers the following topics: (1) heat energy needs for agricultural buildings and for crop drying and (2) selecting building materials based on heat energy needs. (KC)

7th and 8th Grade Agriculture Science Curriculum

Teacher Materials ***Heat Energy***



1. Heat Energy
2. Electromagnetic Spectrum
3. Solar Energy
4. Mechanical Advantage
5. Electrical Energy
6. Energy Conservation

This publication was supported by FCAE/IAVAT/ILCAE/ICAE/FFA and was produced at Southern Illinois University at Carbondale. Funding was provided by ICAE and DAVTE/ISBE.

HEAT ENERGY

BIOLOGICAL AND PHYSICAL SCIENCES

STATE GOAL FOR LEARNING 1

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical and contemporary technological society.

SAMPLE LEARNING OBJECTIVES FOR GOAL 1

By the end of GRADE 8, students should be able to:

F1. Know the laws of conversions of matter, energy, and mass-energy.
F3. Compare the phases of matter.
F5. Understand the effect of heat energy on matter.
G1. Demonstrate that a system is tending toward equilibrium.
G3. Apply factors to an equilibrium that will cause it to shift.

By the end of GRADE 10, students should be able to:

F5. Classify samples of matter by their characteristic physical and chemical properties.

STATE GOAL FOR LEARNING 3

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

SAMPLE LEARNING OBJECTIVES FOR GOAL 3

By the end of GRADE 8, students should be able to:
A1. Compare experimental data to those obtained by others.
A2. Recognize that experimental results are replicable.
A5. Demonstrate effective participation as a member of a laboratory group.
B1. Relate hypotheses or working assumptions in a concise manner.
B2. Demonstrate alternative procedures for solving a problem.
B3. Understand the need to acquire, organize, and evaluate data.
B4. Relate why controlled variables are used in an experiment.
B5. Demonstrate accurate measuring techniques.
B6. Relate a laboratory procedure that another student can follow.

By the end of GRADE 10, students should be able to:

A1. Replicate the results of an experiment.
A2. Recognize that their experimental results must be open to the scrutiny of others.

A4. Recognize the difference between methods used by scientists and the process by which myths and superstitions develop.

B3. Demonstrate the ability to draw conclusions from collected data.
B4. Demonstrate various ways to display the same data.

STATE GOAL FOR LEARNING 4

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment and available technology of science.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

By the end of GRADE 8, students should be able to:
C1. Recognize an inference based upon experimental observation.
D1. Evaluate the validity of a prediction through experimentation.
F1. Report the results of an experiment using tables and graphs.
G1. Develop an appropriate procedure for analyzing data.
L1. Demonstrate reliability by repeating an experiment.

By the end of GRADE 10, students should be able to:

F1. Analyze the results of an experiment.
G1. Evaluate the interpretation of data collected during an experiment.

PHYSICAL DEVELOPMENT
STATE GOAL FOR LEARNING 3

As a result of their schooling, students will be able to understand consumer health and safety, including environmental health.

SAMPLE LEARNING OBJECTIVES FOR GOAL 3

By the end of GRADE 8, students should be able to:
A2. Perform with appropriate safety equipment in safe environments.
G1. Know safety procedures needed in schools and the home to prevent accidents.

By the end of GRADE 10, students should be able to:
A2. Perform with appropriate safety equipment in safe environments.

LANGUAGE ARTS
STATE GOAL FOR LEARNING 4

As a result of their schooling, students will be able to use spoken language effectively in formal and informal situations to communicate ideas and information and to ask and answer questions.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

By the end of GRADE 8, students should be able to:

C2. Distinguish among statements of observation, opinion, and judgment.

MATHEMATICS

STATE GOAL FOR LEARNING 1

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions, and decimals.

SAMPLE LEARNING OBJECTIVES FOR GOAL 1

By the end of GRADE 8, students should be able to:

B2. Divide fractions.
B3. Add and subtract integers.
C1. Translate combinatorial multiplication situations into number sentences and solve and vice versa. (Example: With 5 pants and 7 shirts, how many different outfits does Kelly have?)
C2. Translate rate division situations into number sentences and solve and vice versa. (Example: If a person types 400 words in 9 minutes, about how many words are typed per minute?)
H4. Read diagrams, flowcharts, and schematics.

STATE GOAL FOR LEARNING 2

As a result of their schooling, students will be able to understand and use ratios and percentages.

SAMPLE LEARNING OBJECTIVES FOR GOAL 2

By the end of GRADE 8, students should be able to:

B1. Set up proportions to correspond to appropriate English statements of relationships among quantities.
C2. Write proportions involving corresponding lengths in similar figures.

By the end of GRADE 10, students should be able to:

C1. Solve problems leading to proportions involving area in similar figures.
E1. Solve problems involving percent of increase, percent of decrease, mark-up, and inflation.

STATE GOAL FOR LEARNING 4

As a result of their schooling, students will be able to identify, analyze and solve problems using algebraic equations, inequalities, functions and their graphs.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

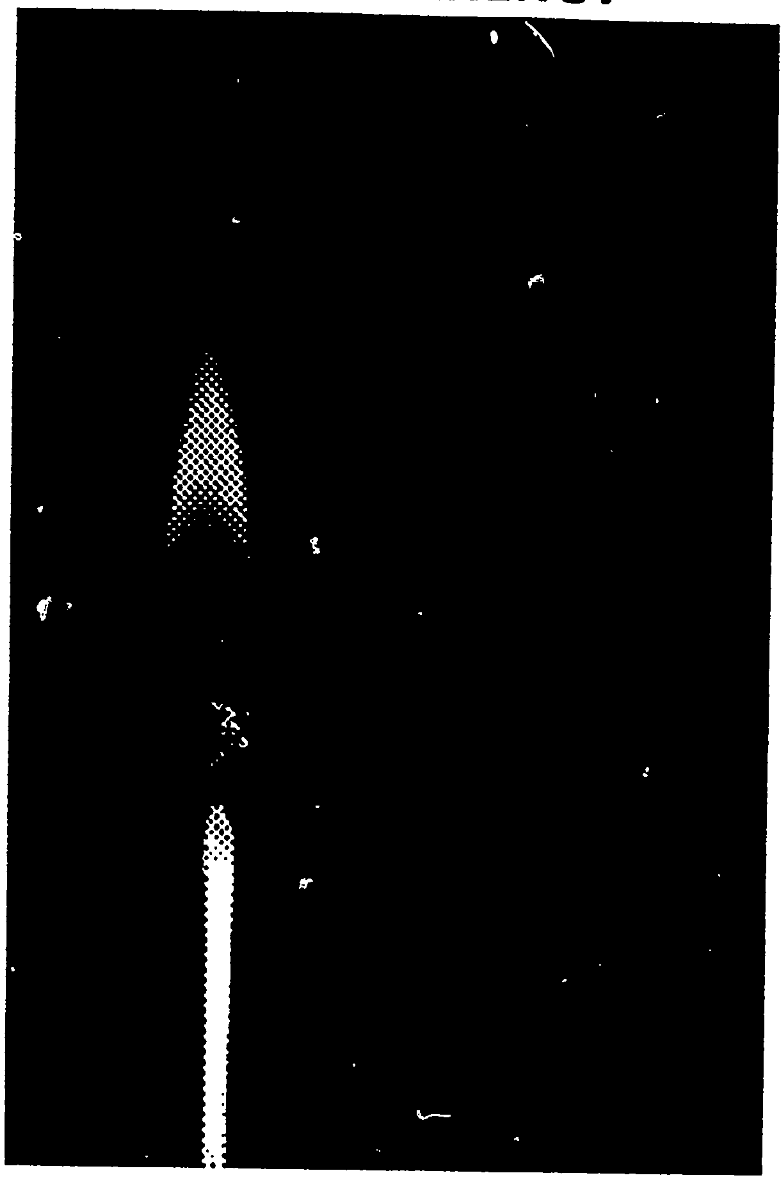
By the end of GRADE 8, students should be able to:

B2. Solve one-step equations.
D2. Solve for a variable in a simple formula when given values for all other variables.
D3. Use values from a real situation for the variables in a formula and solve.

By the end of GRADE 10, students should be able to:

F4. Multiply binomials.

PHYSICAL PRINCIPLES OF HEAT ENERGY



TEACHER PRESENTATION OUTLINE

HEAT ENERGY

AGRICULTURAL PRACTICES

Plan heat energy needs for Agricultural buildings.
Estimate heat energy requirements for Agricultural needs.
Estimate heat energy requirements for crop drying.
Select building materials based on heat energy needs.

SCIENCE CONCEPTS

Heat Transfer
Measures of Heat
Conservation of Energy
Specific Heat

AGRICULTURAL APPLICATIONS FOR 7&8TH GRADE PHYSICAL SCIENCES:

UNIT TITLES:	ACTIVITIES & APPLICATIONS
Heat Energy	1. Fruit growers; page 8 2. Tractor radiation; pg 5 3. Cow heat; pg 69 4. Hog heat; pg 76

TEACHING STEPS

(for teacher to follow)

A. Materials Provided in Teaching Kit:

Electric heater
Water containers
Container insulators
Thermometers
2 inch plastic foam
1 inch plywood

B. Additional Materials Needed for Student Activities:

a 8 inch concrete block

C. Lesson Outline

D. Teacher's Presentation Outline

E. Audio Visual Materials:

1. Measures of heat
2. Heat transfer
3. Specific heat
4. Conservation of energy
5. Heat transfer
6. Insulation
7. Wall Construction
8. Heat transfer formula
9. Sample Heat Flow Problem
10. 5 parts of the wall
11. Formula for U
12. Finishing the Problem
13. Computing Square Feet
14. Computing Heat Loss for Walls & Ceiling

F. Student Handouts and Quizzes

Student Information Guide
Work Sheet A
Work Sheet B
Work Sheet C
Work Sheet D
Student Activity -1 Information Sheet
Student Activity - 1 Record Sheet
Quiz 1
Quiz 2

LESSON OUTLINE:

Day 1:

Discussion of Attention Step/Problem Statement.
Scientific Explanation of Heat as Energy.
Assignment of Student Information Guide: Heat Energy Transfer.
Student Completion of Work Sheet A during Class.
Explanation of Scientific Terms.
Student Completion of Work Sheet B during class or as homework.
Individual Study Using Computer Study Guide.

Day 2:

Discussion of Work Sheet B.
Explanation of General Information about Heat Transfer and Specific Heat.
Demonstration of Student Activity - 1 "Insulation & Heat Transfer Experiments"
Student Activity - 1 "Insulation & Heat Transfer Experiments".
Assignment of Student Activity - 1 Record Sheet.
Individual Study Using Computer Study Guide.
Discussion of Student Activity - 1.

Day 3:

Explanation of Heat Transfer.
Calculation of Heat transfer through Non Homogenous material.
Student Completion of Work Sheet C during Class.
Review of Heat as Energy, Heat Transfer, & Specific Heat.
Individual Study Using Computer Study Guide.

Day 4:

Student Completion of Quiz 1.
Review of formula for determining heat flow through a non homogenous wall.
Student Completion of Work Sheet D: Practice Problem.
Individual Evaluation Using Computer Quiz.

Day 5:

Discussion of Work Sheet D: Practice Problem.
Individual Evaluation Using Computer Quiz.
Completion of Problem Quiz.

PHYSICAL PRINCIPLES OF HEAT ENERGY

TEACHER'S PRESENTATION OUTLINE

Day 1

Teaching Note: *Discuss the Attention Step/Problem Statement with the class.*

ATTENTION STEP/PROBLEM STATEMENT:

The temperature inside a tractor or car engine is hot enough to melt the motor. The only way you can go down the highway or across the field, is if the engine heat is transferred to the atmosphere quickly enough to prevent the engine from melting. The moving motor parts will melt or weld together if the fluids surrounding the engine could not keep it cool.

OBJECTIVES:

KNOWLEDGE OBJECTIVES:

Students will know:

- definition of heat
- definition of temperature
- common celsius measures of temperature
- common fahrenheit measures of temperature
- 2 factors effecting heat transfer
- Joules as a measure of heat energy
- definition of specific heat
- why water is a good substance to use for heat transfer problems
- the physical law of conservation of energy
- 3 types of heat transfer
- 2 types of cooling transfers of energy
- 2 characteristics of a good insulator

PERFORMANCE OBJECTIVES:

Students will:

- compute heat transfer though a non homogenous wall
- measure heat loss through 2 insulating substances
- detect heat transfer differences in 2 substances

HEAT AS A TRANSFER OF ENERGY

Teaching Note: *Explain the following information about the Scientific Explanation of HEAT ENERGY to the class. (Some teachers may want to explain the Scientific Terms and assign Work Sheet B before starting the Scientific Explanation of HEAT ENERGY.)*

Scientific Explanation of HEAT AS ENERGY
Lecture Note: Use overhead #1

Detection of heat is an every day occurrence for most of us. We are interested in knowing the outdoor measure of heat as soon as we wake up in the morning. We insulate ourselves with more or less clothes depending on the morning weather and the forecast for the day. We drink something cold to cool us, or we eat hot foods on a cold day. We use TEMPERATURE to measure the presence of heat. Notice that the changes in temperature happen when heat is transferred from one place to another, the sun transfers heat to our planet Earth. Hot soup transfers heat to our stomach. Touching the sides of a hot cup of coffee will warm our hands by transferring heat from the hot cup to our cold hands. The transfer will continue until both the cup and the hand reach the same temperature. A tractor radiator uses fluids to transfer heat away from its engine to keep it cool.

Heat is produced when energy moves from one substance to another. Heat is energy which is transferred from one substance to another.

- Temperature measures the level of heat in a substance

- We use two common measures of temperature
- These are Celsius and Fahrenheit

- Common measures of Celsius are:
  Body temperature 37 degrees C
  Room temperature 20 degrees C
  Water boiling point 100 degrees C
  Water freezing point 0 degrees C

- Common measures of Fahrenheit are:

  Body temperature 98 degrees F
  Room temperature 72 degrees F
  Water boiling point 212 degrees F
  Water freezing point 32 degrees F

Lecture Note: *Use overhead #2 (Heat Transfer).*

Heat energy moves from a warmer material to a cooler material. Notice what happens when you put an ice cube in your hand. The ice melts and your hand becomes cooler. Heat energy is moving from the warmer hand to the cooler ice cube. When each item reaches the same temperature, the movement of heat energy stops. Again we note that heat energy moves. When you eat a slice of PIZZA which is hot, your tongue heats up and the piece of PIZZA cools. In a similar fashion, when you receive a mild burn to your skin, the suggested first aid step is to run cool water over the burned area. This has the effect of moving the excess heat from the HOT HAND to the cooler water. If done soon enough, heat damage to your skin can be avoided.

How much heat moves and how quickly it moves depends on the type of material involved and the size of the item. Some substances will heat up more quickly than others. The term JOULES is used to measure heat. It takes 450 joules of heat to warm 1 Kilogram of iron 1 degree Celsius. It takes nearly 10 times as much heat to warm 1 Kilogram of water. Water requires the addition of 4180 joules of heat to warm 1 KG 1 degree celsius.

In our daily life, we use these facts to our benefit. The motor of your car is protected from over heating by a radiator which contains water. Water is used because it can absorb a lot of heat. Antifreeze solutions are added to the water in the radiator of cars to further increase the capacity of the radiator to take heat from the motor. Water is a good substance to use to store heat. Many older homes were heated by radiators which were supplied with hot water.

Teaching Note: *Assign Work Sheet A and Student Information Guide on Heat transfer to the class. Students can complete Work Sheet A either individually or in small groups during class time.*

STUDENT INFORMATION GUIDE

HEAT ENERGY TRANSFER

HEAT AS ENERGY

Detection of heat is an every day occurrence for most of us. We are interested in knowing the outdoor measure of heat as soon as we awake in the morning. We insulate ourselves with more or less clothes depending on the morning weather and the forecast for the day. We drink something cold to cool us, or we eat hot foods on a cold day. We use TEMPERATURE to measure the presence of heat. Notice that the changes in temperature are caused when heat is transferred from one place to another, as when the sun transfers heat to our planet Earth. Hot soup transfers heat to our stomach. Touching the sides of a hot cup of coffee will warm our hands. Heat is produced when energy moves from one substance to another. Heat is energy which is transferred from one substance to another.

Temperature is the measure we use to determine the level of heat in a substance. The two most common measures of temperature are Celsius and Fahrenheit. Below are listed some everyday measures of temperature.

Common measures of Celsius are:

Body temperature 37^0 C
Room temperature 20^0 C
Water boiling 100^0 C
Water freezing 0^0 C

Common measures of Fahrenheit are:

Body temperature 98^0 F
Room temperature 72^0 F
Water boiling 212^0 F
Water freezing 32^0 F

HEAT TRANSFER

Heat energy moves from a warmer material to a cooler material. Notice what happens when you put an ice cube in your hand. The ice melts and your hand becomes cooler. Heat energy is moving from the warmer hand to the cooler ice cube. When each item reaches the same temperature, the movement of heat energy stops. Again we note that heat energy moves. When you eat a slice of PIZZA which is hot, your tongue heats up and the piece of PIZZA cools. In a similar fashion, when you receive a mild burn to your skin, the suggested first aid step is to run cool water over the burned area. This has the effect of moving the excess heat from the HOT HAND to the cooler water. If done soon enough, heat damage to your skin can be avoided.

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In our daily life, we use these facts to our benefit. The motor of your car is protected from over heating by a radiator which contains water. Water is used because it can absorb a lot of heat.

Antifreeze solutions are added to the water in the radiator of cars to further increase the capacity of the radiator to take heat from the motor. Water is a good substance to use to store heat. Many older homes were heated by radiators which were supplied with hot water.

HEAT TRANSFER & SPECIFIC HEAT
Specific heat is a term used to identify the amount of heat needed to raise the temperature of 1 kg of an item 1 degree celsius. Some items such as iron can be heated easily. Iron has a specific heat of 450 joules. While water has a specific heat value of 4180 joules. Water is a substance which holds heat well. This is one reason why many foods are cooked in water. The heated water will continue to transfer heat to the food for a long period of time. The amount of heat energy transfer which occurs is determined by three features. They are:

1. The type of material used
2. The change in temperature
3. The size of the material heated or cooled.

HEATING & COOLING WATER
Water is used in many ways in heating and cooling. Water changes from a solid to a liquid and to a gas when heat is added. When ice is heated, it begins to melt. The temperature of the melted part of the ice does not increase until all the ice is melted. The same is true when liquid water changes to steam. The temperature of the steam released remains at the boiling point 100 degrees Celsius until all the water is evaporated.

Heat transfer is an important element in much of our daily lives. Our body works to keep our temperature at a constant temperature. We use an understanding of heat transfer to keep the room warm, drive our car and dress for the temperature outside.

Heat moves in three ways, they are:
1) conduction;
2) convection and
3) radiation.

Heat is conducted when it moves through a material and the material does not move. This is how heat moves through the glass in a window or the wall of our room.

When heat moves with the motion of a material,it is called convection. Heat moves through water and air in this manner. This means we can use fans to help spread heat across a room. Hot air will rise and cold air sink. This action is called convection. A farmer who grows crops on hilly land knows that cold air sinks. In the spring of the year, when a late frost might kill fruit crops, farmers understand that cold air sinks. Using this physical science principle, fruit growers will plant trees on the top and side of hills and NOT at the bottom of a valley. This will help them keep tree buds from being frozen when cold air sinks to the bottom of the valley.

Radiation heat is the third means of heat transfer. Heat from the sun moves to earth using radiation. Radiation is also how heat from a fireplace moves across a room. Radiation heat is more effective in increasing the temperature of solids than gasses such as air. Remember this the next time you are near an open fire or a fireplace. Your hands will warm quickly while the air in a room with a fireplace heats slowly.

Insulation is designed to prevent the movement of heat energy. In the winter we try to prevent heat from leaving our homes and in the summer we try to keep the hot air outside.

Air is a poor conductor of heat and can be used as an insulator. We use this principle when designing double glass windows. Most of the increased insulation value achieved by a double glass window is due to the layer of air between the glass. Double glass windows have about 7 times more insulation value than do single glass windows.

The primary reason fiberglass is a good insulator is that it traps air between the fibers of the material and prevents air from moving.

Heat transfer through walls is measured to enable the owner to determine the size heater or air conditioner needed to control the temperature.

Walls are usually constructed for three reasons. These are; for good appearance, strength and to provide insulation against heat or cold. We are interested in determining the insulation value of a wall which has these three features. Brick for appearance, concrete blocks for strength and foam plastic for insulation value.

One problem a contractor faces when building a new building is deciding how large of a heater to put in it. Several factors need to be considered before selecting a heater. They are: the amount of heat that will move through the walls to the outside, the size of the wall, the temperature desired inside the building, and estimated low temperatures outside the building.

The amount of heat that moves through the walls of a building depend on the materials that make up the wall. The amount of heat lost through 8 inches of concrete block wall is going to be different than the amount of heat lost through 2 inches of plastic foam.

Heaters are sold according to the BTU's produced per hour. To know how large of a heater to purchase, the amount of BTU's needed to heat a given room has to be figured.

FORMULA FOR DETERMINING HEATER SIZE

The formula for determining the heater size needed to heat a given room is measured by BTU's.

The formula to do this is:

$Q = U \times A(t1 - t2)$

Q is the quantity of heat measured in BTU's

U is the heat movement per square foot of the wall

A is the number of Square feet in the wall

t1 is the inside temperature

t2 is the outside temperature

U = 1 divided by the total of the heat transfer numbers of the insulation parts of the wall.

SAMPLE PROBLEM

We are designing a wall in a building. The wall we are designing will be made of three substances. These are an 8 inch concrete block, 2 inches of plastic foam and 1 inch plywood on the outside. The wall is to be 20 feet long and 8 feet high.

Our problem is to determine the size heater needed to maintain a 70^0F inside temperature when the outside temperature is as low as 10^0 F.

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To solve this problem, use the BTU formula which was stated before, which is:
Quantity of Heat Measured in BTU's = heat movement per square foot of wall x the number of square feet of the wall (inside temperature - outside temperature) or
Q = U x A(t1-t2).

First, lets figure U in this formula. To figure U, the heat transfer numbers of the insulation parts of the wall must be added together to find the total value or sum. 1 is then divided by the sum.

There are 5 insulation parts to the wall we are designing. They are:

1. A layer of air on the inside wall
2. The 8 inch concrete block
3. The 2 inch plastic foam
4. The 1 inch plywood
5. A layer of air on the outside wall.

The heat transfer numbers for these wall parts are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
TOTAL VALUE	11.47

U = 1 divided by 11.47 or .087

So our formula now reads: Q = .087 x A(t1 - t2)

Next, lets finish our calculations.
Remember we want to maintain a temperature of 70^{0}F inside when the outside temperature is as low as 10^{0}F.

Q = .087 x A(t1 - t2)

Q = .087 x A(70 - 10)

Q = .087 x A(60)

For each square foot of wall,
Q = .087 x 1 (60).

Q = .087 x 60 = 5.22 BTU per foot per hour.

If one wall of the building is 20 feet long and 8 feet high, the heat loss through this wall is 20 x 8 x 5.22 or 835.2 BTU per hour.

Heaters are sold according to the BTU's produced per hour. For this wall, to keep a 70 degree F temperature when the outside temperature is 10 degrees F, we need to put 835.2 BTU's of heat into the building per hour.

Complete the calculation for all 4 walls the same size and a ceiling that is 20 feet by 20 feet. LETS ASSUME THE CEILING HAS THE SAME INSULATING VALUE AS THE WALLS

Four walls x 835.2 plus (20 x 20)x 5.22 = 5,428.8 BTU's of heat through the wall each hour.

Allowances for heating and cooling are becoming more important to design of buildings for business and industry as well to the design of our homes. A well designed building may save enough energy to reduce heating and cooling bills by 50 percent or more.

HEAT ENERGY TERMS TO KNOW

Heat	A form of energy
Heat transfer	The movement from heat energy from one substance to another.
Temperature	The measure of the level of heat.
Celsius	A temperature scale with 0 degrees as the level of freezing water and 100 degrees the level of boiling water.
Fahrenheit	A temperature scale with 32 degrees as the level of freezing water and 212 degrees the level of boiling water.
Joules	A measure of the amount of heat energy. Heat needed to increase 1kg of water 1 degree Celsius.
BTU	British thermal unit a measure of heat. Heat needed to raise 1 pound of water, 1 degree Fahrenheit.
Physical Law of Energy Conservation	Energy can not be created or destroyed.
Conduction	Movement of energy through materials with no movement of the material. This is how heat moves through solids.
Convection	Movement of heat with the movement of the material. This is how heat moves in air and water.
Radiation	Movement of heat through space. This is how heat reaches the Earth from the Sun.
Specific heat	The amount of heat needed to heat 1KG of a substance 1 degree celsius.
Insulators	Materials which slow the movement of heat.
Cooling systems	A series of steps which remove heat from an area or item, such as a room or car engine.
Heating systems	A series of steps which add heat to an area or an item, such as a room a car heater.

WORK SHEET A

Directions: Complete the following questions.

1. Heat tends to move from a ___*hot*___ substance to a ___*cold*___ substance.

2. The two common measures of temperature are:

   ___*Fahrenheit*___

   ___*Celsius*___

3. The term used to measure the amount of heat gained or lost through a material is called ___*joules*___.

4. List the temperatures in Celsius for the following:

   Room temperature ___*20*___

   Body temperature ___*37*___

   Boil water ___*100*___

   Freeze water ___*0*___

5. List the temperatures in Fahrenheit for the following:

   Room temperature ___*72*___

   Body temperature ___*98*___

   Boil water ___*212*___

   Freeze water ___*32*___

6. List the two features of materials which effect the heat transfer.

   ___*type of material*___

   ___*size of material*___

Teaching Note: *Explain the following terms to the class and then assign Work Sheet B. The students can find the definitions for these terms in the Student Information Guide. Students can complete Work Sheet B during class time or as homework.*

GLOSSARY OF SCIENTIFIC TERMS:

Heat	A form of energy
Heat transfer	The movement from heat energy from one substance to another.
Temperature	The measure of the level of heat.
Celsius	A temperature scale with 0 degrees as the level of freezing water and 100 degrees the level of boiling water.
Fahrenheit	A temperature scale with 32 degrees as the level of freezing water and 212 degrees the level of boiling water.
Joules	A measure of the amount of heat energy. Heat needed to increase 1kg of water 1 degree Celsius.
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WORK SHEET B

Directions:

The answers to the following fill-in-the-blank questions are terms which have something to do with the physical principles of heat energy. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

Heat	Conduction
Convection	Heat transfer
Radiation	Temperature
Specific heat	Celsius
Insulators	Fahrenheit
Cooling systems	Joules
Heating systems	Physical Law of Conservation of Energy
BTU	

Fill-in-the-blank:

1. *Heat* is a form of energy.

2. *Radiation* is the movement of heat through space. This is how heat reaches the Earth from the Sun.

3. The movement of heat energy from one substance to another is called *heat transfer*.

4. The amount of heat needed to heat 1KG of a substance 1 degree celsius is called *specific heat*.

5. A series of steps which remove heat from an area or item, such as a room or car engine is called a *cooling system*.

6. *Temperature* is the measure of the level of heat.

7. *Celsius* is a temperature scale with 0 degrees as the level of freezing water and 100 degrees the level of boiling water.

8. Materials which slow the movement of heat are called *insulators*.

9. The physical science law which states, energy cannot be created or destroyed is the *Physical Law of Conservation of Energy*.

10. *Heating system* is a series of steps which add heat to an area or an item, such as a room a car heater.

11. *Fahrenheit*______ is a temperature scale with 32 degrees as the level of freezing water and 212 degrees the level of boiling water.

12. The movement of energy through materials with no movement of the material is called *conduction*______. This is how heat moves through solids.

13. *Joules*_______ is a measure of the amount of heat energy.

14. The movement of heat with the movement of the material is called *convection*________. This is how heat moves in air and water.

15. The amount of heat needed to heat 1 pound of a water 1 degree fahrenheit is called *BTU*______________.

Teaching Note: *The students may use Physical Principles of Heat Energy Study Guide Computer Program for individual study and review of this lesson.*

Day 2

Teaching Note: *Discuss the Scientific Terms Work Sheet (Work Sheet B) with the class.*

Teaching Note: *Explain the following information about Heat Transfer and Specific Heat to the class.*

HEAT TRANSFER & SPECIFIC HEAT

Lecture Note: *Use overhead #3 (Specific Heat).*

- Specific heat is amount of heat energy needed to raise 1kg of a substance 1 degree celsius.

  - Iron specific heat is 450 joules.
  - Water specific heat is 4180 joules.
    Water is a substance which holds heat well. This is one reason why many foods are cooked in water. The heated water will continue to transfer heat to the food for a long period of time.

Lecture Note: Use overhead # 4 (Conservation of Energy)

- A physical science principle is heat energy can NOT be destroyed.

- Heat energy can be transferred.

- The amount of heat energy transfer which occurs is determined by three features. They are:

  1. the type of material used

  2. the change in temperature

  3. the size of the material heated or cooled

- Heat transfer is an important element in much of our daily lives. Our body works to keep our temperature at a constant temperature. We use an understanding of heat transfer to keep the room warm, drive our car and dress for the temperature outside.

Lecture Note: Use overhead # 5 (Heat Transfer).

- The three methods for the transfer of heat energy are: conduction, convection, and radiation.

1. Conduction is the movement of heat through a substance without movement of the substance.

   example: heat through a glass window or the wall of this room.

2. Convection is the transfer of heat energy with the substance and heat in motion.

   example: heat movement in air or water currents. This is how a fan spreads heat across the room and explains why fruit growers may not plant trees at the bottom of a hill because of possible late spring frosts.

3. Radiation is the transfer of energy through space.

   example: Heat from the Sun to Earth, or radiant energy from an open fire such as a fireplace. Heat moves to heat objects faster than the air that surrounds the fire. Notice how your hands warm quickly near an open fire yet the room temperature increases slowly.

Lecture Note: Use overhead # 6 (Insulation).

- Insulation is designed to prevent the movement of heat energy. In the winter we try to prevent heat from leaving our homes and in the summer we try to keep the hot air outside.

- Air is a poor conductor of heat and can be used as an insulator. Double glass windows have about 7 times more insulation value than does a single glass. The primary reason fiberglass is a good insulator is that it traps air and prevents air from moving.

Teaching Note: *Assign and discuss Student Activity - 1 Information Sheet, " Insulation and Heat Transfer Experiments". Provide the students with supplies for the student activity and answer any questions. Coordinate the student activity. Hand out the Student Activity -1 Record Sheet. Assign part A of the Student Activity - 1 Record Sheet. The students will need to record their results of the test in part A of the Student Activity - 1 Record Sheet.*

Teaching Note: *Demonstrate the transfer of heat by measuring the temperature of two containers of water. The containers should contain the same amount of water. Students can take notes and record them on the Student Activity Note Sheet during the teacher demonstration. The steps and procedures are found in the Student Activity - 1 Information Sheet, "Insulation and Heat Transfer Experiment". The activity and demonstration steps are summarized below:*

Preparation: *A supply of water should be heated using the electric coil provided. The teacher needs to provide the class with about a gallon of heated water. Heat water to a temperature between 190 and 200 degrees F.*

Summary: *Divide the students into ten groups. Each student group needs two containers and 1 thermometer. Five student groups will measure the gradual temperature decline difference between an insulated cup and a non insulated cup. The other five groups will measure the rate of heat transfer from a cup of hot water to a cup of cold water with the use of an aluminum rod. Demonstrate how to place the insulation material around one of the two cups for the INSULATION experiment and how to set up the cups for the HEAT TRANSFER experiment. Then pour a measured amount of water in each cup. Measure the water temperature and record on the chart. Once the first measure is recorded, assign the student Activity Record Sheet. Have students measure the temperature at 5 minute intervals until four measurements have been taken. Use the Student Activity Record Sheet to record the information and draw a graph of the temperature change in each cup of water.*

Additional Note: *These activities may be varied by changing the amount of water in the 2 cups to see if volume effects the results. Different insulation materials may be used. Discuss predictions and results with the students.*

STUDENT ACTIVITY NOTE SHEET

List steps to follow:

1. Insulation Experiment:

   a. Getting Heated water

   b. Choosing insulated cup and non insulated cup and/or insulated materials

   c. Measuring the water temperature

   d. Recording the results

2. Heat Transfer Experiment

   a. Getting Heated Water

   b. Placement of aluminum bar, insulated cups, & covers

   c. Measuring the water temperature

   d. Recording the results

3. Other Variations:

STUDENT ACTIVITY - 1
INFORMATION SHEET

INSULATION AND HEAT TRANSFER EXPERIMENTS

Purpose: To determine differences in heat energy transfer.

EXPERIMENT 1 - INSULATION EXPERIMENT

a. **What Each Group of Students Need:**

Heated water
2 non insulated cups & Insulation material or 1 non insulated cup & 1 insulated cup
Thermometer
Student Activity Record Sheet & Graph

b. **Here's How:**

1. Work in your assigned group.
2. Wrap insulation material around one of your non insulated cups or us an insulated cup.
3. Your teacher will heat water to a temperature of 190 to 200 degrees F.
4. Fill each of your cups about two thirds full. Be careful not to spill the hot water. It can cause burns.
5. Measure the temperature of the water in each cup.
6. Record the temperature on the Student Activity Record Sheet and the graph sheet.
7. At 5 minute intervals measure the temperature in each cup.
8. Record the temperature readings on the Student Activity Record Sheet and graph sheet for each reading.
9. Repeat until 5 temperatures have been recorded for each cup.
10. Draw the graph lines which represent the temperature drop for each cup.
11. Empty the warm water into the teachers container.
12. Clean up your work area.

EXPERIMENT 2 - HEAT TRANSFER EXPERIMENT

a. **What Each Group of Students Need:**
Heated water
2 insulated cups with lids
Thermometer
Aluminum Bar
Student Activity Record Sheet & Graph

b. **Here's How:**

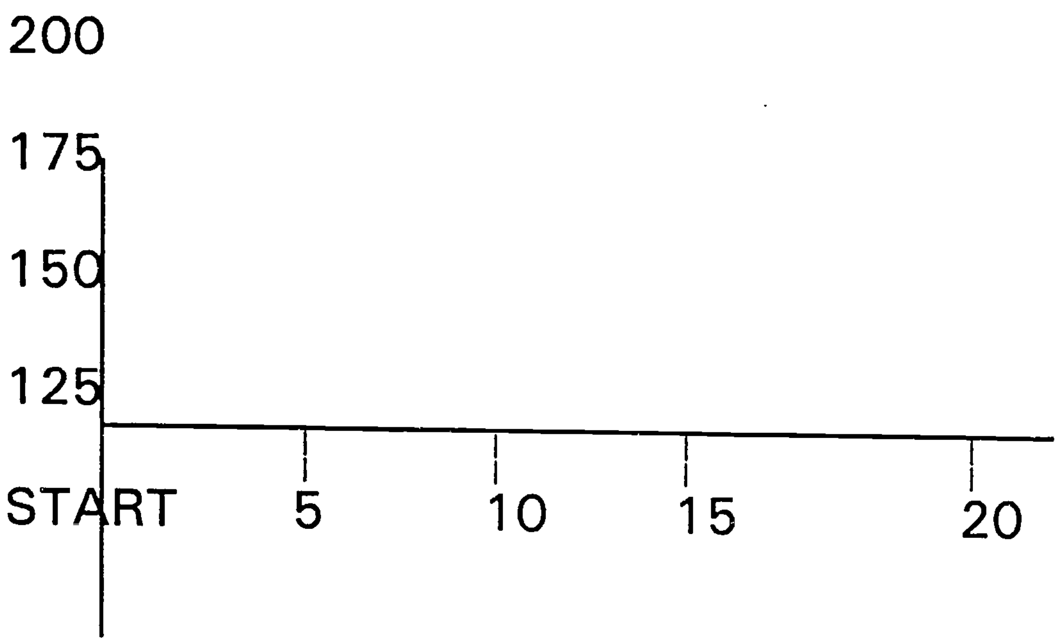
1. Work in your assigned group.
2. Your teacher will heat water to a temperature of 190 to 200 degrees F.
3. Fill one of your cups about two thirds full. Be careful not to spill the hot water. It can cause burns.
4. Fill the other cup about two thirds full with cool water.
5. Measure the temperature of the water in each cup.
6. Record the temperature on the Student Activity Record Sheet and the graph sheet.
7. Insert the aluminum bar in the 2 cups of water and put the lids on the cups.
8. At 5 minute intervals measure the temperature in each cup.
9. Record the temperature readings on the Student Activity Record Sheet and graph sheet for each reading.
10. Repeat until 5 temperatures have been recorded for each cup.
11. Draw the graph lines which represent the temperature drop for each cup.
12. Empty the warm water into the teachers container.
13. Clean ._. your work area.

STUDENT ACTIVITY - 1
RECORD SHEET

A. Record Data Here:

TEMPERATURE READING	HOT CUP OR INSULATED CUP	OTHER CUP
1. At beginning	________	________
2. 5 minutes	________	________
3. 10 minutes	________	________
4. 15 minutes	________	________
5. 20 minutes	________	________

GRAPH OF TEMPERATURE CHANGES



Teaching Note: *Discuss the results of Student Activity - 1 "Insulation and Heat Transfer Experiments" with the class.*

Teaching Note: *The students may use Physical Principles of Heat Energy Study Guide Computer Program for individual study and review for this lesson.*

DAY 3

Teaching Note: *Explain the following information about Heat Transfer to the Class.*

Lecture Note: *Use overhead # 7 (Wall Construction).*

- Heat transfer through walls is measured to enable the owner to determine the size heater or air conditioner needed to control the temperature.

- Walls are usually constructed for three reasons. These are; for good appearance, strength and to provide insulation against heat or cold. We are interested in determining the insulation value of a wall which has these three features:

  - Brick for appearance,

  - concrete blocks for strength, and

  - foam for insulation value.

- One problem a contractor faces when building a new building is deciding how large of a heater to put in it. Several factors need to be considered before selecting a heater. They are:

  1. the amount of heat that will move through the walls to the outside,

  2. the size of the wall,

  3. the temperature desired inside the building, and

  4. estimated low temperatures outside the building.

- The amount of heat that moves through the walls of a building depends on the materials that make up the wall. The amount of heat lost through 8 inches of concrete block wall is going to be different than the amount of heat lost through 2 inches of plastic foam.

- Heaters are sold according to the BTU's produced per hour. To know how large of a heater to purchase, the amount of BTU's needed to heat a given room has to be figured.

Teaching Note: *Explain the following formula for calculation of heat transfer through Non Homogenous material to the class.*

Lecture Note: *Use overhead # 8 (Heat Transfer Formula).*

FORMULA FOR DETERMINING HEATER SIZE

- The formula for determining the heater size needed to heat a given room is measured by BTU's.

The formula to do this is:

Q = U x A(t1-t2)

Q is the quantity of heat measured in BTU's

U is the heat movement per square foot of the wall

A is the number of Square feet in the wall

t1 is the inside temperature

t2 is the outside temperature

U = 1 divided by the total of the heat transfer numbers of the insulation parts of the wall.

Teaching Note: *Explain the following sample heat flow problem to the class. Tell the students they will be assigned some problems similar to this one.*

Lecture Note: *Use overhead # 9 (Sample Heat Flow Problem).*

SAMPLE PROBLEM

- We are designing a wall in a building. The wall we are designing will be made of three substances. These are an 8 inch concrete block, 2 inches of plastic foam and 1 inch plywood on the outside. The wall is to be 20 feet long and 8 feet high.

- Our problem is to determine the size heater needed to maintain a 70^0F inside temperature when the outside temperature is as low as 10^0 F.

- To solve this problem, use the BTU formula that was stated before, which is:

  Quantity of Heat Measured in BTU's = heat movement per square foot of wall x the number of square feet of the wall (inside temperature - outside temperature) or

  $Q = U \times A(t1-t2)$.

- *First, lets figure U in this formula. To figure U, the heat transfer numbers of the insulation parts of the wall must be added together to find the total value or sum. 1 is then divided by the sum.*

Lecture Note: *Use overhead #10 (5 Parts of the Wall).*

- There are 5 insulation parts to the wall we are designing. They are:

  1. A layer of air on the inside wall
  2. The 8 inch concrete block
  3. The 2 inch plastic foam
  4. The 1 inch plywood
  5. A layer of air on the outside wall.

- The heat transfer numbers for these wall parts are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
TOTAL VALUE	11.47

Lecture Note: *Use overhead # 11 (Formula for U).*

U = 1 divided by 11.47 or .087

So our formula now reads: $Q = .087 \times A(t1 - t2)$

Lecture Note: *Use overhead # 12 (Finishing the Problem).*

- *Next, lets finish our calculations.*
  Remember we want to maintain a temperature of 70°F inside when the outside temperature is as low as 10°F.

  $Q = .087 \times A(t1 - t2)$

  $Q = .087 \times A(70 - 60)$

  $Q = .087 \times A(60)$

- For each square foot of wall,
  $Q = .087 \times 1\ (60)$.

  $Q = .087 \times 60 = 5.22$ BTU per foot per hour for each square foot of wall.

Lecture Note: *Use overhead #13 (Computing Square Feet).*

- If one wall of the building is 20 feet long and 8 feet high, the heat loss through this wall is 20 x 8 x 5.22 or 835.2 BTU per hour.

- Heaters are sold according to the BTU's produced per hour.For this wall, to keep a 70 degree F temperature when the outside temperature is 10 degrees F, we need to put 835.2 BTU's of heat into the building per hour.

Lecture Note: *Use overhead # 14 (Computing Heat Loss for walls & ceiling).*

- Complete the calculation for 4 more walls the same size and a ceiling that is 20 feet by 20 feet. LETS ASSUME THE CEILING HAS THE SAME INSULATING VALUE AS THE WALLS

  Four walls x 835.2 plus (20 x 20)x 5.22 = 5,428.8 BTU's of heat through the wall each hour.

- Allowances for heating and cooling are becoming more important to design of buildings for business and industry as well to the design of our homes. A well designed building may save enough energy to reduce heating and cooling bills by 50 percent or more.

Teaching Note: *Have students complete Work Sheet C during class time. This work sheet shows the steps in solving Heat Transfer Problems. If possible, show samples of the materials you are working with in this problem.*

WORK SHEET C

Directions: Solve the following problem and write the correct answer in the blanks:

A new building is being planned. The building is to be 20 feet long and 20 feet wide and 8 feet high. The walls are to be made of an 8" concrete block as the inside wall, a 2" layer of foam in the middle and a 1" plywood outside wall. The problem is to determine the size heater needed to keep the building heated to 70 degrees F when the temperature is as low as 10 degrees F outside.

1. The formula to do this is Q = U x A (t1-t2)

   Q is the *quantity of heat in BTU's*

   U is the *heat transfer per square foot*

   A is the *Area in square feet*

   t1 is the *inside temperature*

   t2 is the *outside temperature*

   U = 1 divided by the sum of the heat transfer numbers of the substances in the wall.

2. There are 5 insulation parts to this wall. They are:

   a. *inside air*

   b. *8" concrete*

   c. *2" foam*

   d. *1" plywood*

   e. *outside air*

3. The heat transfer numbers for each part of the wall are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17

TOTAL VALUE *11.47*

4. U = 1 divided by 11.47 = *.087*.

5. For each square foot of wall, Q = .087 x the temperature difference.

   Q = .087 x 60 = *5.22* BTU per foot per hour.

6. If one wall of the building is 20 feet long and 8 feet high, the heat loss through this wall is 20 x 8 x 5.22 or *835.2* BTU's per hour.

7. Heaters are sold according to the BTU's produced per hour. For this wall, to keep a 70 degree F temperature when the outside temperature is 10 degrees F, we need to put *835.2* BTU's of heat into the building per hour.

8. Complete the calculation for 4 more walls the same size and a ceiling that is 20 feet by 20 feet. LETS ASSUME THE CEILING HAS THE SAME INSULATING VALUE AS THE WALLS.

   a. Four walls x 835.2 = *3340.8* BTU's for the walls.

   b. The ceiling is 20 feet by 20 feet or 400 square feet. Ceiling heat loss is 400 x *5.22* = 2088 BTU's

   c. A total of *3340.8* BTU's lost through the 4 walls plus a ceiling loss of 2088 BTU's adds up to 5,428.8 BTU's of heat is transferred through the building when the outside temperature is 10 degrees F and the inside temperature is 70 degrees F. A heater with a capacity of at least 5,428.8 BTU's should be installed in the building.

Teaching Note: *Review information about Heat as Energy, Heat Transfer, & Specific Heat with the students. Some key facts are listed below.*

Teacher Review:

- We use TEMPERATURE to measure the presence of heat. Notice that the changes in temperature happen when heat is transferred from one place to another, as when the sun transfers heat to our planet Earth.

- Heat is produced when energy moves from one substance to another. Heat is energy which is transferred from one substance to another.

- Temperature measures the level of heat in a substance. We use two common measures of temperature. These are Celsius and Fahrenheit.

  - Common measures of Celsius are:
    Body temperature 37^0 C
    Room temperature 20^0 C
    Water boiling point 100^0 C
    Water freezing point 0^0 C

  - Common measures of Fahrenheit are:
    Body temperature 98^0 F
    Room temperature 72^0 F
    Water boiling point 212^0 F
    Water freezing point 32^0 F

- Heat energy moves from a warmer material to a cooler material. How much heat moves and how quickly it moves depends on the type of material involved and the size of the item. Some substances will heat up more quickly than others. The term JOULES is used to measure heat.

- Specific heat is amount of heat energy needed to raise 1kg of a substance 1 degree celsius.

- Water is a substance which holds heat well. This is one reason why many foods are cooked in water. The heated water will continue to transfer heat to the food for a long period of time.

- A physical science principle is heat energy can NOT be destroyed. Heat energy can be transferred.

- The amount of heat energy transfer which occurs is determined by three features. They are:
  1. the type of material used
  2. the change in temperature
  3. the size of the material heated or cooled

- The three methods for the transfer of heat energy are: conduction, convection, and radiation.

  1. Conduction is the movement of heat through a substance without movement of the substance.
     example: heat through a glass window or the wall of this room.

  2. Convection is the transfer of heat energy with the substance and heat in motion.
     example: heat movement in air or water currents. This is how a fan spreads heat across the room and explains why fruit growers may not plant trees at the bottom of a hill because of possible late spring frosts.

  3. Radiation is the transfer of energy through space.
     example: Heat from the Sun to Earth, or radiant energy from an open fire such as a fireplace. Heat moves to heat objects faster than the air that surrounds the fire. Notice how your hands warm quickly near an open fire yet the room temperature increases slowly.

- Insulation is designed to prevent the movement of heat energy. Air is a poor conductor of heat and can be used as an insulator.

- Heat transfer through walls is measured to enable the owner to determine the size heater or air conditioner needed to control the temperature. Walls are usually constructed for three reasons. These are: for good appearance, strength and to provide insulation against heat or cold.

- The formula for determine the heater size needed to heat a given room is measured by BTU's.

Teaching Note: *The students may use Physical Principles of Heat Energy Study Guide Computer Program for individual study and review of this lesson.*

DAY 4

Teaching Note: *Quiz 1 can be used to evaluate student's knowledge of Physical Principles of Heat Energy.*

QUIZ 1

A. Matching:

Match the best definition with each term:

b	1. 212^0	a.	Celsius Room Temperature.
a	2. 20^0	b.	Fahrenheit water boiling.
d	3. 37^0	c.	Fahrenheit room temperature.
e	4. 100^0	d.	Celsius body temperature.
		e.	Celsius boiling.

B. True or False:

F 5. Heat energy moves from cold substances to warm substances.

T 6. When compared to many substances, water can absorb a lot of heat.

T 7. When two items reach the same temperature, heat transfer will stop.

C. Fill-in-the-blank:

8. The unit of heat measure which is needed to raise the temperature of 1 pound of water 1 degree fahrenheit is called BTU.

9. One joule is the amount of energy needed to increases the temperature of 1KG of water 1 degree Celsius.

D. Short Answer:

10. Name 3 means of heat movement.

a. convection

b. conduction

c. radiation

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Teaching Note: *Review the formula for determining heat flow through a non-homogenous wall. Some key facts are listed below:*

Teacher Review:

- The formula to do this is Q = U*A(t1-t2)

  Q is the quantity of heat measured in BTU's
  U is the heat movement per square foot of the wall
  A is the number of Square feet in the wall
  t1 is the inside temperature
  t2 is the outside temperature

  U = 1 divided by the sum of the heat transfer numbers of the substances in the wall.

- There are 5 insulation parts to this wall. They are:
  1. a layer of air on the inside wall
  2. the 8 inch concrete block
  3. The 2 inch plastic foam
  4. The 1 inch plywood
  5. A layer of air on the outside wall.

- The heat transfer numbers for each part is:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
Total value	11.47

U = 1 divided by 11.47 or .087

For each square foot of wall, Q = .087 * 1 (70-10)
Q = .087 * 60 = 5.22 BTU per foot per hour.

Teaching Note: *Students should complete Work Sheet D: Practice Problem during class time.*

Teaching Note: *Let the class know that a problem quiz will be given in class tomorrow. The problem quiz will be similar to today's practice problem.*

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WORK SHEET D: PRACTICE PROBLEM

Directions: Solve the following problem:

A new building is being planned. The building is to be 80 feet long and 36 feet wide and 8 feet high. The walls are to be made of an 8" concrete block as the inside wall, a 2" layer of foam in the middle and a 1" plywood outside wall. The problem is to determine the size heater needed to keep the building heated to 60 degrees F when the temperature is as low as 0 degrees F outside. The building will be used to keep 50 milk cows warm during the winter months.

- The formula to do this is Q = U x A (t1-t2)

1. Q is the *quantity of heat in BTU's*
2. U is the *heat transfer per square foot*
3. A is the *Area in square feet*
4. t1 is the *inside temperature*
5. t2 is the *outside temperature*

U = 1 divided by the sum of the heat transfer numbers of the substances in the wall.

There are 5 insulation parts to this wall. They are:

6. *inside air*
7. *8" concrete*
8. *2" foam*
9. *1" plywood*
10. *outside air*

11. The heat transfer numbers for each part of the wall are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
Total value	*11.47*

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12. U = 1 divided by 11.47 is equal to .087 .

13. For each square foot of wall, Q = .087 x the temperature difference.

Q = .087 x 60 = 5.22 BTU per foot per hour.

14. If the two end walls of the building are 36 feet long and 8 feet high, the heat loss through these walls are 36 x 8 x 5.22 times 2 = 3006.72 BTU's per hour.

15. If the two side walls of the building are 80 feet long and 8 feet high, the heat loss through these walls are 80 x 8 x 5.22 times 2 = 6681.60 BTU's per hour.

16. If the ceiling of the building is 80 feet long and 36 feet wide, the heat loss through the ceiling is 80 x 36 x 5.22 or 15033.60 BTU's per hour.

Total heat loss is determined by adding the three numbers above and subtracting the amount of heat produced by the 50 cows. A cow is estimated to produce 300 BTU's per hour.

17. Cow heat multiply the number of cows by the heat produced per cow. 50 cows x 300 = 15,000 BTU's.

ADD three heat loss numbers:

18. SIDE WALL LOSS 6681.60

19. END WALL LOSS 3006.72

20. CEILING LOSS 15033.60

=================

21. TOTAL LOSS 24721.92

22. LESS COW HEAT 15000.00

23. BTU's NEEDED 9721.92

Teaching Note: *The students may use the Physical Principles of Heat Energy Computer Quiz for individual evaluation of their knowledge.*

Day 5

Review the SOLUTION TO THE COW BARN PROBLEM in Work Sheet D: Practice Problem prior to giving the Problem QUIZ.

Teaching Note: *The students may use the Physical Principles of Heat Energy Computer Quiz for individual evaluation of their knowledge.*

PROBLEM QUIZ

Directions: Solve the following problem:

A new building is being planned. The building is to be 40 feet long and 20 feet wide and 10 feet high. The walls are to be made of an 8" concrete block as the inside wall, a 2" layer of foam in the middle and a 1" plywood outside wall. The problem is to determine the size heater needed to keep the building heated to 70 degrees F when the temperature is as low as 10 degrees F outside. The building will be used to keep 100 PIGS warm during the winter months.

- The formula to do this is Q = U x A (t1-t2)

1. Q is the *quantity of heat in BTU's*
2. U is the *heat transfer per square foot*
3. A is the *Area in square feet*
4. t1 is the *inside temperature*
5. t2 is the *outside temperature*

U = 1 divided by the sum of the heat transfer numbers of the substances in the wall.

There are 5 insulation parts to this wall. They are:

6. *inside air*
7. *8" concrete*
8. *2" foam*
9. *1" plywood*
10. *outside air*

The heat transfer numbers for each part of the wall are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
Total value	11.47

11. U = 1 divided by 11.47 is equal to *.087*.

12. For each square foot of wall, Q = .087 x the temperature difference.

Q = .087 x 60 = 5.22 BTU per foot per hour.

13. If the two end walls of the building are 20 feet long and 10 feet high, the heat loss through these walls are 20 x 10 x 5.22 times 2 or
2088 BTU's per hour.

14. If the two side walls of the building are 40 feet long and 10 feet high, the heat loss through these walls are 40 x 10 x 5.22 times 2 or
4176 BTU's per hour.

15. If the ceiling of the building is 40 feet long and 20 feet wide, the heat loss through the ceiling is 40 x 20 x 5.22 or
4176 BTU's per hour.

Total heat loss is determined by adding the three numbers above and subtracting the amount of heat produced by the 100 pigs. A pig is estimated to produce 100 BTU's per hour.

16. PIG heat; multiply the number of pigs by the heat produced per pig. 100 pigs x 100 = 10,000 BTU's.

ADD three heat loss numbers:

17. SIDE WALL LOSS 4176

18. END WALL LOSS 2088

19. CEILING LOSS 4176

================

20. TOTAL LOSS 10440

21. LESS PIG HEAT 10000

22. BTU's NEEDED 440

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D. Audio Visual Materials:

1. Measures of heat
2. Heat transfer
3. Specific heat
4. Conservation of energy
5. Heat transfer
6. Insulation
7. Wall Construction
8. Heat transfer formula
9. Sample Heat Flow Problem
10. 5 parts of the wall
11. Formula for U
12. Finishing the Problem
13. Computing Square Feet
14. Computing Heat Loss for Walls & Ceiling

TEMPERATURE
MEASURE OF HEAT

37^0 CELSIUS 98^0 FAHRENHEIT
BODY TEMPERATURE

100^0 CELSIUS 212^0 FAHRENHEIT
BOILING WATER

0^0 CELSIUS 32^0 FAHRENHEIT
FREEZING WATER

20^0 CELSIUS 72^0 FAHRENHEIT
ROOM TEMPERATURE

HEAT TRANSFER

1. TYPE OF MATERIAL

2. SIZE OF MATERIAL

3. JOULES (unit of heat)
   450 Joules to heat
   1KG OF IRON 1 DEGREE C

4. EXAMPLE
   4180 J TO HEAT 1KG WATER
   450 J TO HEAT 1KG IRON

IRON HEATS EASIER THAN WATER

SPECIFIC HEAT

AMOUNT OF HEAT TO CHANGE

1 KG 1 DEGREE CELSIUS

SPECIFIC HEAT FOR:

WATER = 4180 J

IRON = 450 J

OH4

CONSERVATION OF ENERGY

1. PHYSICAL LAW

2. CAN NOT DESTROY

3. CAN TRANSFER HEAT

HEAT TRANSFER

1. CONDUCTION
   METALS

2. CONVECTION
   LIQUID
   GAS

3. RADIATION
   SPACE

INSULATION

AIR IS A POOR CONDUCTOR OF HEAT

INSULATORS TRAP AIR

DOUBLE GLASS TRAPS AIR

FIBER INSULATORS TRAP AIR

WALL CONSTRUCTION

1. APPEARANCE

   PLYWOOD

2. STRENGTH

   CONCRETE BLOCK

3. INSULATION

   FOAM PLASTIC

HEAT FLOW FORMULA

$$Q = U \times A (t1 - t2)$$

Q = BTU'S OF HEAT

U = HEAT FLOW PER SQUARE FOOT

A = SQUARE FEET IN WALL

t1 = INSIDE TEMPERATURE

t2 = OUTSIDE TEMPERATURE

SAMPLE HEAT FLOW PROBLEM:

TO DETERMINE THE SIZE OF HEATER FOR A NEW BUILDING

BUILDING MUST MAINTAIN A 70° F INSIDE TEMPERATURE WHEN OUTSIDE TEMPERATURE IS 10° F

BUILDING'S WALLS ARE 20 FEET LONG AND 8 FEET HIGH

WALLS ARE MADE UP OF CONCRETE BLOCK, PLASTIC FOAM, & PLYWOOD

5 PARTS OF THE WALL

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
Total value	11.47

FORMULA FOR U

U = HEAT FLOW PER SQUARE FOOT (1 DIVIDED BY THE SUM OF THE HEAT TRANSFER NUMBERS OF THE PARTS OF THE WALL)

U = 1 DIVIDED BY 10.47 OR .087 FOR EACH SQUARE FOOT OF WALL.

THE FORMULA TO FIND Q, NOW READS:

Q = .087 * 1 (t1 - t2)

FINISHING THE PROBLEM

FOR EACH SQUARE FOOT OF WALL,

Q = .087 * 1 (t1 - t2)

Q = .087 * 1 (70-10)

Q = .087 * 60

Q = 5.22 BTU per square foot per hour

HEAT TRANSFER RATE IS:

5.22 BTU per foot per hour.

COMPUTING SQUARE FEET

COMPUTE THE NUMBER OF SQUARE FEET IN THE WALL

SQ FT = LENGTH x WIDTH OF WALL

THE WALL IS 20′ BY 8′

SQ FT = 20 x 8

SQ FT = 160

Q = U x A

Q = 5.22 x 160

Q = 835.2 BTU'S PER HOUR

COMPUTING HEAT LOSS FOR WALLS & CEILING

HEAT LOSS FOR ALL WALLS AND THE CEILING

BUILDING IS 20 x 20 ft

4 SIDES = 4 x 160 = 640

CEILING = 20 x 20 = 400

Q = U * A

Q = 5.22 x 1040

Q = 5428.8 BTU PER HOUR

E. Student Handouts and Quizzes

Student Information Guide - Heat Energy Transfer

Work Sheet A

Work Sheet B

Work Sheet C

Work Sheet D

Student Activity Information Sheet

Student Activity Record Sheet

Quiz 1

Problem Quiz

STUDENT INFORMATION GUIDE

HEAT ENERGY TRANSFER

HEAT AS ENERGY

Detection of heat is an every day occurrence for most of us. We are interested in knowing the outdoor measure of heat as soon as we awake in the morning. We insulate ourselves with more or less clothes depending on the morning weather and the forecast for the day. We drink something cold to cool us, or we eat hot foods on a cold day. We use TEMPERATURE to measure the presence of heat. Notice that the changes in temperature are caused when heat is transferred from one place to another, as when the sun transfers heat to our planet Earth. Hot soup transfers heat to our stomach. Touching the sides of a hot cup of coffee will warm our hands. Heat is produces when energy moves from one substance to another. Heat is energy which is transferred from one substance to another.

Temperature is the measure we use to determine the level of heat in a substance. The two most common measures of temperature are Celsius and Fahrenheit. Below are listed some everyday measures of temperature.

Common measures of Celsius are:

Body temperature 37^0 C
Room temperature 20^0 C
Water boiling 100^0 C
Water freezing 0^0 C

Common measures of Fahrenheit are:

Body temperature 98^0 F
Room temperature 72^0 F
Water boiling 212^0 F
Water freezing 32^0 F

HEAT TRANSFER

Heat energy moves from a warmer material to a cooler material. Notice what happens when you put an ice cube in your hand. The ice melts and your hand becomes cooler. Heat energy is moving from the warmer hand to the cooler ice cube. When each item reaches the same temperature, the movement of heat energy stops. Again we note that heat energy moves. When you eat a slice of PIZZA which is hot, your tongue heats up and the piece of PIZZA cools. In a similar fashion, when you receive a mild burn to your skin, the suggested first aid step is to run cool water over the burned area. This has the effect of moving the excess heat from the HOT HAND to the cooler water. If done soon enough, heat damage to your skin can be avoided.

How much heat moves and how quickly it moves depends on the type of material involved and the size of the material. Some substances will heat up more quickly than others. The term JOULES is used to measure heat. It takes 450 joules of heat to warm 1 Kilogram of iron 1 degree Celsius. It takes nearly 10 times as much heat to warm 1 Kilogram of water. Water requires the addition of 4180 joules of heat to warm 1 KG 1 degree celsius.

In our daily life, we use these facts to our benefit. The motor of your car is protected from over heating by a radiator which contains water. Water is used because it can absorb a lot of heat.

Antifreeze solutions are added to the water in the radiator of cars to further increase the capacity of the radiator to take heat from the motor. Water is a good substance to use to store heat. Many older homes were heated by radiators which were supplied with hot water.

HEAT TRANSFER & SPECIFIC HEAT
Specific heat is a term used to identify the amount of heat needed to raise the temperature of 1 kg of an item 1 degree celsius. Some items such as iron can be heated easily. Iron has a specific heat of 450 joules. While water has a specific heat value of 4180 joules. Water is a substance which holds heat well. This is one reason why many foods are cooked in water. The heated water will continue to transfer heat to the food for a long period of time. The amount of heat energy transfer which occurs is determined by three features. They are:

1. the type of material used
2. The change in temperature
3. The size of the material heated or cooled.

HEATING & COOLING WATER
Water is used in many ways in heating and cooling. Water changes from a solid to a liquid and to a gas when heat is added. When ice is heated, it begins to melt. The temperature of the melted part of the ice does not increase until all the ice is melted. The same is true when liquid water changes to steam. The temperature of the steam released remains at the boiling point 100 degrees Celsius until all the water is evaporated.

Heat transfer is an important element in much of our daily lives. Our body works to keep our temperature at a constant temperature. We use an understanding of heat transfer to keep the room warm, drive our car and dress for the temperature outside.

Heat moves in three ways, they are:
1) conduction;
2) convection and
3) radiation.

Heat is conducted when it moves through a material and the material does not move. This is how heat moves through the glass in a window or the wall of our room.

When heat moves with the motion of a material,it is called convection. Heat moves through water and air in this manner. This means we can use fans to help spread heat across a room. Hot air will rise and cold air sink. This action is called convection. A farmer who grows crops on hilly land knows that cold air sinks. In the spring of the year, when a late frost might kill fruit crops, farmers understand that cold air sinks. Using this physical science principle, fruit growers will plant trees on the top and side of hills and NOT at the bottom of a valley. This will help them keep tree buds from being frozen when cold air sinks to the bottom of the valley.

Radiation heat is the third means of heat transfer. Heat from the sun moves to earth using radiation. Radiation is also how heat from a fireplace moves across a room. Radiation heat is more effective in increasing the temperature of solids than gasses such as air. Remember this the next time you are near an open fire or a fireplace. Your hands will warm quickly while the air in a room with a fireplace heats slowly.

Insulation is designed to prevent the movement of heat energy. In the winter we try to prevent heat from leaving our homes and in the summer we try to keep the hot air outside.

Air is a poor conductor of heat and can be used as an insulator. We use this principle when designing double glass windows. Most of the increased insulation value achieved by a double glass window is due to the layer of air between the glass. Double glass windows have about 7 times more insulation value than do single glass windows.

The primary reason fiberglass is a good insulator is that it traps air between the fibers of the material and prevents air from moving.

Heat transfer through walls is measured to enable the owner to determine the size heater or air conditioner needed to control the temperature.

Walls are usually constructed for three reasons. These are; for good appearance, strength and to provide insulation against heat or cold. We are interested in determining the insulation value of a wall which has these three features. Brick for appearance, concrete blocks for strength and foam plastic for insulation value.

One problem a contractor faces when building a new building is deciding how large of a heater to put in it. Several factors need to be considered before selecting a heater. They are: the amount of heat that will move through the walls to the outside, the size of the wall, the temperature desired inside the building, and estimated low temperatures outside the building.

The amount of heat that moves through the walls of a building depend on the materials that make up the wall. The amount of heat lost through 8 inches of concrete block wall is going to be different than the amount of heat lost through 2 inches of plastic foam.

Heaters are sold according to the BTU's produced per hour. To know how large of a heater to purchase, the amount of BTU's needed to heat a given room has to be figured.

FORMULA FOR DETERMINING HEATER SIZE

The formula for determining the heater size needed to heat a given room is measured by BTU's.

The formula to do this is:

$Q = U \times A(t1-t2)$

Q is the quantity of heat measured in BTU's

U is the heat movement per square foot of the wall

A is the number of Square feet in the wall

t1 is the inside temperature

t2 is the outside temperature

U = 1 divided by the total of the heat transfer numbers of the insulation parts of the wall.

SAMPLE PROBLEM

We are designing a wall in a building. The wall we are designing will be made of three substances. These are an 8 inch concrete block, 2 inches of plastic foam and 1 inch plywood on the outside. The wall is to be 20 feet long and 8 feet high.

Our problem is to determine the size heater needed to maintain a 70^0F inside temperature when the outside temperature is as low as 10^0 F.

To solve this problem, use the BTU formula which was stated before, which is:
Quantity of Heat Measured in BTU's = heat movement per square foot of wall x the number of square feet of the wall (inside temperature - outside temperature) or
Q = U x A(t1-t2).

First, lets figure U in this formula. To figure U, the heat transfer numbers of the insulation parts of the wall must be added together to find the total value or sum. 1 is then divided by the sum.

There are 5 insulation parts to the wall we are designing. They are:

1. A layer of air on the inside wall
2. The 8 inch concrete block
3. The 2 inch plastic foam
4. The 1 inch plywood
5. A layer of air on the outside wall.

The heat transfer numbers for these wall parts are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
TOTAL VALUE	11.47

U = 1 divided by 11.47 or .087

So our formula now reads: Q = .087 x A(t1 - t2)

Next, lets finish our calculations.
Remember we want to maintain a temperature of 70^{0}F inside when the outside temperature is as low as 10^{0}F.

Q = .087 x A(t1 - t2)

Q = .087 x A(70 - 60)

Q = .087 x A(60)

For each square foot of wall,
Q = .087 x 1 (60).

Q = .087 x 60 = 5.22 BTU per foot per hour.

If one wall of the building is 20 feet long and 8 feet high, the heat loss through this wall is 20 x 8 x 5.22 or 835.2 BTU per hour.

Heaters are sold according to the BTU's produced per hour. For this wall, to keep a 70 degree F temperature when the outside temperature is 10 degrees F, we need to put 835.2 BTU's of heat into the building per hour.

Complete the calculation for 4 more walls the same size and a ceiling that is 20 feet by 20 feet. LETS ASSUME THE CEILING HAS THE SAME INSULATING VALUE AS THE WALLS

Four walls x 835.2 plus (20 x 20)x 5.22 = 5,428.8 BTU's of heat through the wall each hour.

Allowances for heating and cooling are becoming more important to design of buildings for business and industry as well to the design of our homes. A well designed building may save enough energy to reduce heating and cooling bills by 50 percent or more.

HEAT ENERGY TERMS TO KNOW

Heat	A form of energy
Heat transfer	The movement from heat energy from one substance to another.
Temperature	The measure of the level of heat.
Celsius	A temperature scale with 0 degrees as the level of freezing water and 100 degrees the level of boiling water.
Fahrenheit	A temperature scale with 32 degrees as the level of freezing water and 212 degrees the level of boiling water.
Joules	A measure of the amount of heat energy. Heat needed to increase 1kg of water 1 degree Celsius.
BTU	British thermal unit a measure of heat. Heat needed to raise 1 pound of water, 1 degree Fahrenheit.
Physical Law of Energy Conservation	Energy can not be created or destroyed.
Conduction	Movement of energy through materials with no movement of the material. This is how heat moves through solids.
Convection	Movement of heat with the movement of the material. This is how heat moves in air and water.
Radiation	Movement of heat through space. This is how heat reaches the Earth from the Sun.
Specific heat	The amount of heat needed to heat 1KG of a substance 1 degree celsius.
Insulators	Materials which slow the movement of heat.
Cooling systems	A series of steps which remove heat from an area or item, such as a room or car engine.
Heating systems	A series of steps which add heat to an area or an item, such as a room a car heater.

WORK SHEET A

Directions: Complete the following questions.

1. Heat tends to move from a ______________ substance to a ______________ substance.

2. The two common measures of temperature are:

   ____

   ____

3. The term used to measure the amount of heat gained or lost through a material is called ________.

4. List the temperatures in Celsius for the following:

   Room temperature ________

   Body temperature ________

   Boil water ________

   Freeze water ________

5. List the temperatures in Fahrenheit for the following:

   Room temperature ________

   Body temperature ________

   Boil water ________

   Freeze water ________

6. List the two features of materials which effect the heat transfer.

   ____

   ____

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WORK SHEET B

Directions:

The answers to the following fill-in-the-blank questions are terms which have something to do with the physical principles of heat energy. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

Heat	Conduction
Convection	Heat transfer
Radiation	Temperature
Specific heat	Celsius
Insulators	Fahrenheit
Cooling systems	Joules
Heating systems	Physical Law of Conservation of Energy
BTU	

Fill-in-the-blank:

1. ______________ is a form of energy.

2. ______________ is the movement of heat through space. This is how heat reaches the Earth from the Sun.

3. The movement of heat energy from one substance to another is called ________________.

4. The amount of heat needed to heat 1KG of a substance 1 degree celsius is called __________________.

5. A series of steps which remove heat from an area or item, such as a room or car engine is called a ____________________.

6. _________________ is the measure of the level of heat.

7. _________________ is a temperature scale with 0 degrees as the level of freezing water and 100 degrees the level of boiling water.

8. Materials which slow the movement of heat are called ______.

9. The physical science law which states, energy cannot be created or destroyed is the ____.

10. _______________ is a series of steps which add heat to an area or an item, such as a room a car heater.

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11. ____________________ is a temperature scale with 32 degrees as the level of freezing water and 212 degrees the level of boiling water.

12. The movement of energy through materials with no movement of the material is called ____________________. This is how heat moves through solids.

13. ________________ is a measure of the amount of heat energy.

14. The movement of heat with the movement of the material is called ______________________. This is how heat moves in air and water.

15. The amount of heat needed to heat 1 pound of a water 1 degree fahrenheit is called ____________________.

WORK SHEET C

Directions: Solve the following problem and write the correct answer in the blanks:

A new building is being planned. The building is to be 20 feet long and 20 feet wide and 8 feet high. The walls are to be made of an 8" concrete block as the inside wall, a 2" layer of foam in the middle and a 1" plywood outside wall. The problem is to determine the size heater needed to keep the building heated to 70 degrees F when the temperature is as low as 10 degrees F outside.

1. The formula to do this is Q = U x A (t1-t2)

   Q is the ______________________________

   U is the ______________________________

   A is the ______________________________

   t1 is the ______________________________

   t2 is the ______________________________

   U = 1 divided by the sum of the heat transfer numbers of the substances in the wall.

2. There are 5 insulation parts to this wall. They are:

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

3. The heat transfer numbers for each part of the wall are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
TOTAL VALUE	______

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4. U = 1 divided by 11.47 = ____________________.

5. For each square foot of wall, Q = .087 x the temperature difference.

   Q = .087 x 60 = _____________ BTU per foot per hour.

6. If one wall of the building is 20 feet long and 8 feet high, the heat loss through this wall is 20 x 8 x 5.22 or _______________________ BTU's per hour.

7. Heaters are sold according to the BTU's produced per hour. For this wall, to keep a 70 degree F temperature when the outside temperature is 10 degrees F, we need to put _______ BTU's of heat into the building per hour.

8. Complete the calculation for 4 more walls the same size and a ceiling that is 20 feet by 20 feet. LETS ASSUME THE CEILING HAS THE SAME INSULATING VALUE AS THE WALLS.

   a. Four walls x 835.2 = _______________ BTU's for the walls.

   b. The ceiling is 20 feet by 20 feet or 400 square feet. Ceiling heat loss is 400 x _______ = 2088 BTU's

   c. A total of _____________ BTU's lost through the 4 walls plus a ceiling loss of 2088 BTU's adds up to 5,428.8 BTU's of heat is transferred through the building when the outside temperature is 10 degrees F and the inside temperature is 70 degrees F. A heater with a capacity of at least 5,428.8 BTU's should be installed in the building.

WORK SHEET D: PRACTICE PROBLEM

Directions: Solve the following problem:

A new building is being planned. The building is to be 80 feet long and 36 feet wide and 8 feet high. The walls are to be made of an 8" concrete block as the inside wall, a 2" layer of foam in the middle and a 1" plywood outside wall. The problem is to determine the size heater needed to keep the building heated to 60 degrees F when the temperature is as low as 0 degrees F outside. The building will be used to keep 50 milk cows warm during the winter months.

- The formula to do this is $Q = U \times A\ (t1-t2)$

1. Q is the ______________________________
2. U is the ______________________________
3. A is the ______________________________
4. t1 is the ______________________________
5. t2 is the ______________________________

U = 1 divided by the sum of the heat transfer numbers of the substances in the wall.

There are 5 insulation parts to this wall. They are:

6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

11. The heat transfer numbers for each part of the wall are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
Total value	______

12. U = 1 divided by 11.47 is equal to ________________.

13. For each square foot of wall, Q = .087 x the temperature difference.

Q = .087 x 60 = ____________ BTU per foot per hour.

14. If the two end walls of the building are 36 feet long and 8 feet high, the heat loss through these walls are 36 x 8 x 5.22 times 2 =
____________________ BTU's per hour.

15. If the two side walls of the building are 80 feet long and 8 feet high, the heat loss through these walls are 80 x 8 x 5.22 times 2 =
____________________ BTU's per hour.

16. If the ceiling of the building is 80 feet long and 36 feet wide, the heat loss through the ceiling is 80 x 36 x 5.22 or ____________________ BTU's per hour.

Total heat loss is determined by adding the three numbers above and subtracting the amount of heat produced by the 50 cows. A cow is estimated to produce 300 BTU's per hour.

17. Cow heat multiply the number of cows by the heat produced per cow. ____________ cows x 300 = ______________ BTU's.

ADD three heat loss numbers:

18. SIDE WALL LOSS ________________

19. END WALL LOSS ________________

20. CEILING LOSS ________________

================

21. TOTAL LOSS ________________

22. LESS COW HEAT ________________

23. BTU's NEEDED ________________

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STUDENT ACTIVITY - 1
INFORMATION SHEET

INSULATION AND HEAT TRANSFER EXPERIMENTS

Purpose: To determine differences in heat energy transfer.

EXPERIMENT 1 - INSULATION EXPERIMENT

a. **What Each Group of Students Need:**

Heated water
2 non insulated cups & Insulation material or 1 non insulated cup & 1 insulated cup
Thermometer
Student Activity Record Sheet & Graph

b. **Here's How:**

1. Work in your assigned group.
2. Wrap insulation material around one of your non insulated cups or us an insulated cup.
3. Your teacher will heat water to a temperature of 190 to 200 degrees F.
4. Fill each of your cups about two thirds full. Be careful not to spill the hot water. It can cause burns.
5. Measure the temperature of the water in each cup.
6. Record the temperature on the Student Activity Record Sheet.
7. At 5 minute intervals measure the temperature in each cup.
8. Record the temperature readings on the Student Activity Record Sheet for each reading.
9. Repeat until 5 temperatures have been recorded for each cup.
10. Draw the graph lines which represent the temperature drop for each cup.
11. Empty the warm water into the teachers container.
12. Clean up your work area.

EXPERIMENT 2 - HEAT TRANSFER EXPERIMENT

a. **What Each Group of Students Need:**
Heated water
2 insulated cups with lids
Thermometer
Aluminum Bar
Student Activity Record Sheet & Graph

b. **Here s How:**

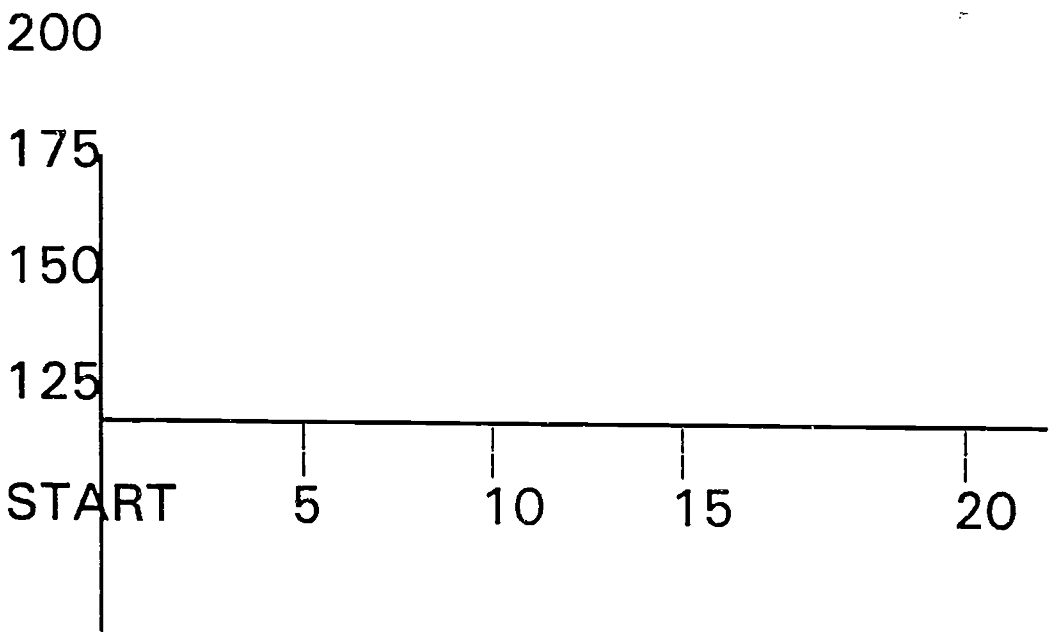
1. Work in your assigned group.
2. Your teacher will heat water to a temperature of 190 to 200 degrees F.
3. Fill one of your cups about two thirds full. Be careful not to spill the hot water. It can cause burns.
4. Fill the other cup about two thirds full with cool water.
5. Measure the temperature of the water in each cup.
6. Record the temperature on the Student Activity Record Sheet.
7. Insert the aluminum bar in the 2 cups of water and put the lids on the cups.
8. At 5 minute intervals measure the temperature in each cup.
9. Record the temperature readings on the Student Activity Record Sheet for each reading.
10. Repeat until 5 temperatures have been recorded for each cup.
11. Draw the graph lines which represent the temperature drop for each cup.
12. Empty the warm water into the teachers container.
13. Clean up your work area.

STUDENT ACTIVITY - 1
RECORD SHEET

A. Record Data Here:

TEMPERATURE READING	HOT CUP OR INSULATED CUP	OTHER CUP
1. At beginning	________	________
2. 5 minutes	________	________
3. 10 minutes	________	________
4. 15 minutes	________	________
5. 20 minutes	________	________

GRAPH OF TEMPERATURE CHANGES



QUIZ 1

A. Matching:

Match the best definition with each term:

______1. 212^0	a. Celsius Room Temperature.
______2. 20^0	b. Fahrenheit water boiling.
______3. 32^0	c. Fahrenheit room temperature.
______4. 100^0	d. Celsius body temperature.
	e. Celsius boiling.

B. True or False:

______ 5. Heat energy moves from cold substances to warm substances.

______ 6. When compared to many substances, water can absorb a lot of heat.

______ 7. When two items reach the same temperature, heat transfer will stop.

C. Fill-in-the-blank:

8. The unit of heat measure which is needed to raise the temperature of 1 pound of water 1 degree fahrenheit is called ______________________.

9. One ________________ is the amount of energy needed to increases the temperature of 1KG of water 1 degree Celsius.

D. Short Answer:

10. Name 3 means of heat movement.

    a. ______________________________

    b. ______________________________

    c. ______________________________

PROBLEM QUIZ

Directions: Solve the following problem:

A new building is being planned. The building is to be 40 feet long and 20 feet wide and 10 feet high. The walls are to be made of an 8" concrete block as the inside wall, a 2" layer of foam in the middle and a 1" plywood outside wall. The problem is to determine the size heater needed to keep the building heated to 70 degrees F when the temperature is as low as 10 degrees F outside. The building will be used to keep 100 PIGS warm during the winter months.

- The formula to do this is Q = U x A (t1-t2)

1. Q is the ______________________________
2. U is the ______________________________
3. A is the ______________________________
4. t1 is the ______________________________
5. t2 is the ______________________________

U = 1 divided by the sum of the heat transfer numbers of the substances in the wall.

There are 5 insulation parts to this wall. They are:

6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

The heat transfer numbers for each part of the wall are:

Inside air	.61
8" Concrete	1.11
2" foam	8.33
1" Plywood	1.25
Outside air	.17
Total value	11.47

11. U = 1 divided by 11.47 is equal to ____________________.

12. For each square foot of wall, Q = .087 x the temperature difference.

Q = .087 x 60 = ____________ BTU per foot per hour.

13. If the two end walls of the building are 20 feet long and 10 feet high, the heat loss through these walls are 20 x 10 x 5.22 times 2 or
______________________ BTU's per hour.

14. If the two side walls of the building are 40 feet long and 10 feet high, the heat loss through these walls are 40 x 10 x 5.22 times 2 or
_____________________ BTU's per hour.

15. If the ceiling of the building is 40 feet long and 20 feet wide, the heat loss through the ceiling is 40 x 20 x 5.22 or
_____________________ BTU's per hour.

Total heat loss is determined by adding the three numbers above and subtracting the amount of heat produced by the 100 pigs. A pig is estimated to produce 100 BTU's per hour.

16. PIG heat; multiply the number of pigs by the heat produced per pig. _____________ pigs x 100 = _______________ BTU's.

ADD three heat loss numbers:

17. SIDE WALL LOSS ___________________

18. END WALL LOSS ___________________

19. CEILING LOSS ___________________

=================

20. TOTAL LOSS ___________________

21. LESS PIG HEAT ___________________

22. BTU's NEEDED ___________________